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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/662,525	09/16/2003	Minh Van Ngo	50432-642	1701
7590	12/10/2004		EXAMINER	
McDERMOTT, WILL & EMERY 600 13th Street, N.W. Washington, DC 20005-3096			VU, QUANG D	
			ART UNIT	PAPER NUMBER
			2811	

DATE MAILED: 12/10/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

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Office Action Summary	Application No. 10/662,525	Applicant(s) NGO ET AL.	
	Examiner Quang D Vu	Art Unit 2811	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 15 September 2004.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 11-20 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 11-20 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all

obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. Claim 11 is rejected under 35 U.S.C. 103(a) as being unpatentable over US Patent No. 6,429,524 to Cooney, III et al. in view of US Patent No. 6,657,284 to Li et al. and US Patent Application Publication No. 2001/0018137 to Chiang et al.

Regarding claim 11, Cooney et al. (figure 1A-5) teach a semiconductor device comprising:

an opening in a dielectric layer (100); and

a composite barrier layer (tantalum nitride layer [135] and a layer of alpha tantalum [140])

formed on a surface of the dielectric layer (100) lining the opening; wherein:

the composite barrier layer comprises:

a layer of tantalum nitride (135) containing N₂ (column 6, lines 55-58); and

a layer of alpha tantalum (140) on the tantalum nitride layer (135) (tantalum is deposited on the tantalum nitride layer, and an alpha phase tantalum [alpha tantalum] is formed; column 1, lines 46-49).

Cooney, III et al. differ from the claimed invention by not showing the surface of the dielectric layer comprises a nitrogen (N₂)-enriched surface region. However, Li et al. teach the

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dielectric layer (14b) comprises a nitrogen rich surface region (column 6, lines 13-18).

Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to incorporate the teaching of Li et al. into the device taught by Cooney, III et al. in order to reduce the dielectric constant of the dielectric layer.

Cooney, III et al. and Li et al. differ from the claimed invention by not showing the tantalum nitride containing nitrogen in an amount decreasing in the direction away from the nitrogen surface region. However, Chiang et al. teach decreasing nitrogen in the tantalum nitride layer (paragraph [0006]). Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to incorporate the teaching of Chiang et al. into the device taught by Cooney, III et al. and Li et al. in order to enhance the property of the barrier layer.

3. Claims 12-17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Cooney, III et al. and Li et al. in view of Chiang et al., and further in view of US Patent No. 6,326,301 to Venkatesan et al.

The disclosures of Cooney, III et al., Li et al. and Chiang et al. are discussed as applied to claim 11 above.

Regarding claim 12, the combined device differs from the claimed invention by not showing the dielectric layer comprises fluorine (F)-containing silicon oxide derived from F-doped tetraethylorthosilicate (F-TEOS). However, Venkatesan et al. teach F-TEOS dielectric layer (column 5, lines 56-62). Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to incorporate the teaching of Venkatesan et al.

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into the device taught by Cooney, III et al., Li et al. and Chiang et al. in order to produce high quality of the dielectric layer.

Regarding claim 13, the combined device shows the nitrogen- enriched surface region contains F in an amount less than the remainder of the dielectric layer.

Regarding claim 14, the combined device differs from the claimed invention by not showing the N₂-enriched region has a thickness of about 10 Angstroms to about 20 Angstroms. It would have been obvious to one having ordinary skill in the art at the time the invention was made for the N₂-enriched region has a thickness of about 10 Angstroms to about 20Angstroms in order to reduce the dielectric constant of the dielectric layer. Furthermore, it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. In re Aller, 105 USPQ 233.

The combined device differs from the claimed invention by not showing the graded tantalum nitride layer has a thickness of about 20Angstroms to about 50Angstroms. It would have been obvious to one having ordinary skill in the art at the time the invention was made for the graded tantalum nitride layer has a thickness of about 20Angstroms to about 50Angstroms in order to form a barrier layer. Furthermore, it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. In re Aller, 105 USPQ 233.

The combined device further differs from the claimed invention by not showing the α -Ta layer has a thickness of about 200 Angstroms to about 300 Angstroms. It would have been obvious to one having ordinary skill in the art at the time the invention was made for the α -Ta layer has a thickness of about 200 Angstroms to about 300 Angstroms in order to reduce the

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resistivity of the device. Furthermore, it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. In re Aller, 105 USPQ 233.

Regarding claim 15, the combined device differs from the claimed invention by not showing the nitrogen-enriched region contains about 10 to about 40 at % N₂. It would have been obvious to one having ordinary skill in the art at the time the invention was made for the nitrogen-enriched region contains about 10 to about 40 at % N₂ in order to reduce the dielectric constant of the dielectric layer. Furthermore, it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. In re Aller, 105 USPQ 233.

The combined device further differs from the claimed invention by not showing the graded tantalum nitride region contains N₂ in an amount of about 5 to about 15 at % proximate the N₂-enriched region decreasing toward the α -Ta layer. It would have been obvious to one having ordinary skill in the art at the time the invention was made for the graded tantalum nitride region contains N₂ in an amount of about 5 to about 15 at % proximate the N₂-enriched region decreasing toward the α -Ta layer in order to prevent the diffusion of the metal layer. Furthermore, it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. In re Aller, 105 USPQ 233.

Regarding claim 16, the combined device shows the opening is filled with copper (Cooney, III et al.; 150).

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Regarding claim 17, the combined device shows the opening is a dual damascene (Cooney, III et al.; column 1, lines 13-15) opening comprising a lower via hole (Cooney, III et al.; a lower portion of the trench [115]) in communication with an upper trench (Cooney, III et al.; an upper portion of the trench [115]); and the filled opening (Cooney, III et al.; the filled material copper [150]) comprises a Cu via in communication with an upper Cu.

4. Claim 18 is rejected under 35 U.S.C. 103(a) as being unpatentable over Cooney, III et al. and Li et al. in view Chiang et al., and further in view of US Patent No. 6,548,400 to Brennan et al.

Regarding claim 18, the disclosures of Cooney, III et al., Li et al. and Chiang are discussed as applied to claim 11 above.

The combined device differs from the claimed invention by not showing the dielectric layer comprises a dielectric material having a dielectric constant (k) less than about 3.9. However, Brennan et al. shows the dielectric constant of dielectric layer less than 3.9 (column 4, line 66 – column 5, line 3). Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to incorporate the teaching of Brennan et al. into the device taught by Cooney, III et al., Li et al. and Chiang et al. in order to reduce the interconnection parasitic capacitance of the device.

5. Claim 19 is rejected under 35 U.S.C. 103(a) as being unpatentable over Cooney, III et al., Li et al. and Chiang et al. in view of Brennan et al., and further in view of US Patent No. 6,265,779 to Grill et al.

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Regarding claim 19, the disclosures of Cooney, III et al., Li et al., Chiang et al. and Brennan et al. are discussed as applied to claim 18 above.

The combined device differs from the claimed invention by not showing the dielectric material is a halogen-containing material. However, Grill et al. teach halogen-containing dielectric (column 4, lines 59-60). Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to incorporate the teaching of Grill et al. into the device taught by Cooney, III et al., Li et al., Chiang et al. and Brennan et al. in order to reduce the resistivity of the substrate.

6. Claim 20 is rejected under 35 U.S.C. 103(a) as being unpatentable over Cooney, III et al., Li et al. and Chiang et al. in view of Brennan et al., and further in view US Patent No. 6,326,301 to Venkatesan et al.

Regarding claim 20, the disclosures of Cooney, III et al., Li et al., Chiang et al. and Brennan et al. are discussed as applied to claim 18 above.

The combined device differs from the claimed invention by not showing the dielectric material is a fluorine (F)-containing oxide. However, Venkatesan et al. teach F-TEOS dielectric layer (column 5, lines 56-62). Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to incorporate the teaching of Venkatesan et al. into the device taught by Cooney, III et al., Li et al., Chiang et al. and Brennan et al. in order to produce high quality of the dielectric layer.

Response to Arguments

Applicant's arguments with respect to claims 11-20 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Quang D Vu whose telephone number is 571-272-1667. The examiner can normally be reached on Monday-Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Eddie Lee can be reached on 571-272-1732. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

qv
November 26, 2004



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